## GC32A MC: Hall D Wednesday 1330h

### Climate Observing System Challenges II *(joint with A, B, H, OS)*

***Presiding:*** **B A Wielicki,** Nasa Langley Research Center**; R E Davis,** Scripps Institutionof Oceanography

#### GC32A-0208 1330h POSTER

### Far-Infrared Spectroscopy of the Troposphere

Martin G Mlynczak[1] (757-864-5695; m.g.mlynczak@larc.nasa.gov); David Johnson[2] (757-864-8580; d.g.johnson@larc.nasa.gov); Edward Kist[2] (e.h.kist@larc.nasa.gov); David Kratz[1] (d.p.kratz@larc.nasa.gov); Christopher Mertens[3] (c.j.mertens@larc.nasa.gov); William Collins[4] (wcolllins@ucar.edu)

[1]NASA Langley Research Center, Mail Stop 420, Hampton, VA 23681-2199, United States

[2]NASA Langley Research Center, Mail Stop 468, Hampton, VA 23681-2199, United States

[3]NASA Langley Research Center, Mail Stop 401B, Hampton, VA 23681-2199, United States

[4]National Center for Atmospheric Research, 1850 Table Mesa Drive, Boulder, CO 80303, United States

The far-infrared, defined herein as the spectral region between 15 and 100 micrometers, is a virtually unobserved component of the infrared emission spectrum of the Earth and its atmosphere. The radiative balance of the troposphere is influenced strongly by radiative cooling associated with emission by water vapor at far-infrared wavelengths extending out beyond 50 micrometers. Up to half of the outgoing longwave radiation from the Earth occurs in the far-infrared, depending on atmospheric and surface conditions. The distribution of water vapor and associated far-IR radiative forcings and feedbacks are well recognized as major uncertainties in understanding and predicting future climate. Despite this fundamental importance, far-infrared emission (spectra or band-integrated) has rarely been directly measured from space, airborne, or ground-based platforms. Current and planned operational and research satellites typically observe the mid-infrared only to about 15.4 micrometers. NASA has recently selected the Far-Infrared Spectroscopy of the Troposphere (FIRST) project for development under its Instrument Incubator Program (IIP). FIRST will observe the infrared emission spectrum between 10 and 100 micrometers. FIRST is envisioned as the next-generation atmospheric sounder, combining both radiation budget measurements with atmospheric profiling capability. In this talk we will review the importance of the far-infrared, discuss the FIRST instrument, and highlight the role of far-infrared observations in the overall climate observing system of the future.

#### GC32A-0209 1330h POSTER

### Greenhouse Effect and its Altitude Gradients - by Accurate Surface Longwave Radiation Measurements

Rolf - Philipona[1] (+41 81 417 5131; rphilipona@pmodwrc.ch)

Christoph - Marty[2] (+1 907 474 7360; chris@nanuna.gi.alaska.edu)

[1]Physikalisch-Meteorologisches Observatorium Davos and World Radiation Center, Dorfstrasse 33, Davos Dorf CH-7260, Switzerland

[2]Geophysical Institute, University of Alaska Fairbanks, 903 Koyukuk Drive, Fairbanks, AK 99775, United States

Alarming temperature rises measured on the Earth's surface during the past decades are most likely related to an enhanced greenhouse effect. The greenhouse effect has so far been investigated with satellite measurements, but more than 90 percent of the clear-sky greenhouse radiative flux acting on the Earth's surface originates from a 1000 meter thick layer right above the surface. Broadband longwave radiation measurements and its uncertainty are now greatly improved and the linear relationship between clear-sky greenhouse effect and longwave downward radiation allows to determine the clear-sky greenhouse effect by accurate longwave measurements from the surface. Surface measurements further allow to measure the effect of clouds and by adding the longwave cloud radiative forcing to the clear-sky greenhouse effect, the all-sky greenhouse effect can be determined. Measurements at eleven radiation stations in the Alps show large seasonal variations of the clear-sky and all-sky greenhouse effect and their altitude gradients, demonstrating the strong coupling to climatological surface parameters and the potential of such measurements to substantiate the connection between greenhouse gas increases and surface temperature rises at specific climate zones.

#### GC32A-0210 1330h POSTER

### Prospects for measurement of far infrared tropospheric spectra: Implications for climate modeling

William D Collins[1] (+1 303-497-1381; wcollins@ucar.edu)

Martin G Mlynczak[2] (+1 757-864-5695; m.g.mlynczak@larc.nasa.gov)

[1]NCAR, P.O. Box 3000, Boulder, CO 80307-3000, United States

[2]NASA Langley Research Center, Mail Stop 420, 21 Langley Blvd., Hampton, VA 23681-2199, United States

A substantial fraction of the Earth's thermal radiation is emitted in far-infrared wavelengths between 15 and 100 $\mu$m. Some of the strongest radiative interactions with water vapor occur in the far-infrared rotation bands. Approximately 60–70% of the natural greenhouse effect and 70–80% of the radiative feedbacks from doubling carbon dioxide are due to water vapor. Despite its importance for the climate system, this part of the spectrum was last measured from space-born instruments over 25 years ago. By contrast, several spectral intervals in the mid-infrared are routinely measured for operational temperature and humidity soundings. Several general circulation models (GCMs) can now simulate the mid-infrared spectrum to test the fidelity of climate simulations. Using a new instrument under development by NASA, it will be possible to extend these tests to longer wavelengths. The Far Infrared Spectroscopy of the Troposphere (FIRST) satellite instrument will provide accurate spectra between 10 and 100 $\mu$m for clear and cloudy regions.

We illustrate why these measurements are critical for improving GCMs using the NCAR Community Atmosphere Model (CAM). We have changed the infrared absorption and emission by water vapor to bring CAM into close agreement with modern line-by-line calculations. The main changes in the radiative heating rates are associated with line and continuum absorption in the rotation band. These changes interact strongly with the convective parameterizations in CAM, leading to significant changes in the simulated thermodynamic state. The significant changes to the mean climate and climate sensitivity are discussed in light of current uncertainties in the foreign component of the water vapor continuum. Far-infrared top-of-atmosphere fluxes are simulated with CAM and compared to the outgoing longwave radiation. These calculations illustrate the utility of FIRST data for evaluating the fidelity of radiative processes in climate simulations.

#### GC32A-0211 1330h POSTER

Francisco PJ Valero (858 534 2701; fvalero@ucsd.edu)

University of California, San Diego Scripps Institution of Oceanography, 9500 Gilman Drive MC 0242, La Jolla, CA 92093, United States

From its location in deep space, Triana will view the Earth in a different way - as an entire planet rather than a patchwork of regions of interest. It will uniquely acquire synoptic (all regions in the sunlit side seen simultaneously) sunrise to sunset, high time resolution data for most points on Earth using state of the art, highly accurate, in flight calibrated instruments.

Triana will collect information on the climate system combining atmospheric dynamics, cloud physics, aerosols, radiation and surface remote sensing. For example, the continuous measurement of the infrared radiation emitted by Earth in the direction of L-1, will provide a stable, highly accurate thermal emission reference parameter, that is thought to be correlated to the temperature at the surface. These measurements will be tested as a surrogate for surface temperature measurements in monitoring "global warming" and climate variability.

Ozone measurements will be used to study upper atmosphere circulation using ozone as a tracer. This is uniquely possible for Triana because it has the necessary synoptic view and temporal and spatial resolutions to allow the description and study of dynamic processes in the upper atmosphere. Surface ultraviolet exposure estimates will be enhanced by the continuous daylight view, surface remote sensing (including the oceans and vegetation canopies) will be made possible by Triana's location at L-1. Measurements of solar wind magnetic field and plasma (density, velocity, temperature) will provide data to study turbulence and solar corona heating and the slow solar wind. Solar wind events will be "seen" by Triana approximately 50 minutes before reaching the Earth's magnetosphere-providing enough time to issue warnings to protect sensitive systems (satellites, etc).

Another contribution of Triana will be as a synergistic link between Earth observing satellites by correlating simultaneous multi-satellite observations, by comparing calibrations, and by helping to build a unified Earth Observations network with the Moon as a calibration reference (Triana will have the Moon in plain view).

The Triana views of our world will be used as a teaching tool that will inspire the quest for knowledge, a quest that we will support with public and elementary to higher education outreach, teacher training and research opportunities for undergraduate and graduate students.

Triana may well be the first Deep Space "climate satellite" and has the potential to prove the unique usefulness of deep space observation points such as L-1 or L-2, for Earth Sciences. The Triana spacecraft and all instruments are built, tested and calibrated. Triana is ready to go.

URL: http://cloud.ucsd.edu

#### GC32A-0212 1330h POSTER

### Scatterometer Image Data for Global Ice and Land Climate Studies

Benjamin Holt[1] (818-354-5473; ben@pacific.jpl.nasa.gov)

David Long[2] (long@byu.edu)

Mark Drinkwater[3] (Mark.Drinkwater@esa.int)

Sasaan Saatchi[1] (Sasann.Saatchi@jpl.nasa.gov)

Cheryl Bertoia[4] (bertoiac@natice.noaa.gov)

[1]Jet Propulsion Laboratory California Institute of Technology , 4800 Oak Grove Drive, Pasadena, CA 91109, United States

[2]Brigham Young University, 459 Clyde Building, Provo, UT 84601, United States

[3]European Space Agency, ESTEC, Keplerann 1, Postbus 299, 200 AG Noordwijk ZH, Netherlands

[4]U. S. National Ice Center , 4251 Suitland Road, Washington, DC 20395, United States

Spaceborne scatterometers have been providing continuous synoptic microwave coverage of the Earth for nearly a decade. Though these scatterometers were originally designed to measure oceanic surface winds, their data have also been found to be extremely useful in a broad range of ice and land applications, including the use of extensive scatterometer time series to determine seasonal and interannual variability and possible relationships to climate change. Under a NASA Earth Science Enterprise grant, the Scatterometer Climate Record Pathfinder (SCP) project has produced non-ocean scatterometer imagery and data products that are now publicly available for the first time. The SCP project is providing imagery from the three NASA scatterometers, including Quikscat, NSCAT, and Seasat, in both a unique enhanced resolution format and an intrinsic resolution format. In addition, new value-added data products from the ERS scatterometers are also available. We will highlight the value of these products for polar and land studies, discuss the SCP site structure, data format, processing, and quality. Scatterometer Image Data for Global Ice and Land Climate Studies

URL: http://www.scp.byu.edu

#### GC32A-0213 1330h POSTER

### Has the Climate Warmed Since 1940?

S. Fred Singer (singer@sepp.org)

University of Virginia Science & Envir. Policy Project, 1600 S. Eads St. Ste 712-S, Arlington, VA 22202, United States

A panel of the National Research Council/National Academy of Sciences has failed to explain fully the disparity between, on the one hand, surface observations showing a warming trend and, on the other hand, satellite and balloon radiosonde measurements that do not show a significant trend. [1] This is especially puzzling since climate models all predict the warming trend to increase (from the surface) with altitude in the troposphere.

I have examined a variety of proxy data that could provide independent evidence of warming but have not found any so far that do. The recent IPCC report reviews proxy data only up to about 1980, showing a temperature no greater than in 1940. [2] The wide geographic distribution of the proxy data thus leads to the suggestion that the global climate has not warmed appreciably in the past 60 years. This conclusion, of course, is subject to revision if other proxy data present contrary evidence.

1. National Research Council. Reconciling Observations of Global Temperature Change. National Academy Press, Wash. DC. 2000

2. IPCC. Climate Change 2001: The Scientific Basis. Cambridge University Press, 2001. Fig.1, p.3

## GC32A-0214 1330h POSTER

### Identifying Issues for Long-Term Data Understandability

Bruce R Barkstrom ((757) 864-5676; b.r.barkstrom@larc.nasa.gov)

Atmospheric Sciences NASA Langley Research Center, MS 420, Hampton, VA 23681-2199, United States

In the past decade, we have seen a serious effort to capture and make useful a record of Earth observations. While the EOSDIS effort has had some success, the longer term prospects for preserving our knowledge of how the Earth has changed must still overcome a number of difficult challenges. The first, and most important, may be moving from the expectation that we can produce a single system that will solve all of the difficulties. Rather, we need to begin to view what we do from the perspective of a continuously evolving digital library. There are several key issues we need to deal with in trying to bring about this shift in perception:

a.We need a *stable data referencing approach* - like a URI, but one that allows us to reference individual data elements and subsets, not just files or data products.

b.We need more *adaptive metadata* - including metadata that allows us to tie together data sets maintained in different places by scientific tribes that are linguistically in different communities of discourse.

c.We need *more automated approaches to ensuring the documentation of data provenance and of the web of scientific discourse* that goes on mostly in scientific journals.

d.We need to find ways of preserving both *the data and its web of meaning* even while we have to transfer it from medium to medium and system to system. The easy part of the problem is transferring the data - and that's the part that's been discussed so far. The hard part is carrying the scholarly apparatus that allows us to accumulate knowledge about what's in the data.

e.We need *additional approaches to visualizing the connections between various data sets and of recording objects* that experts find for deeper examination.

## GC32A-0215 1330h POSTER

### Monitoring Ocean Surface Wind Vector from Space

W. Timothy Liu[1] ((818) 354-2394; liu@pacific.jpl.nasa.gov)

Wenqing Tang[1] ((818) 354-8199; wqt@pacific.jpl.nasa.gov)

[1]Jet Propulsion Laboratory, 4800 Oak Grove Drive MS 300-323, Pasadena, CA 91109, United States

Spaceborne scatterometer is the only proven mean to measure ocean surface wind vector. In the past decade, four scatterometers have been launched. Studies to remove systematic errors from these data sets will be reviewed. Trends and variations in these data set will be compared with major climate indexes.

Historically, scatterometers of the European Space Agency (ESA) used C-band (5 GHz), but the National Aeronautics and Space Administration (NASA) prefers Ku-band (14 GHz). Ku-band is more sensitive to wind variation at low winds but is more subjective to rain contamination. The European Remote Satellite (ERS)-1 and -2 provided nine years of continuous wind data starting 1991, covering 40 percent of the global ocean daily. The backscatters measured have 50-km spatial resolution but are sampled at 25 km. The NASA Scatterometer (NSCAT) covered 77 percent of global ocean at 25-km resolution daily. The unexpected destruction of the solar array caused the early demise of NSCAT in June 1997, after returning 9 months of data. NASA launched QuikSCAT, with new design, in 1999. It covers 93 percent of the global ocean in a single day. The standard wind product has 25-km spatial resolution, but special products with 12.5-km resolution for selected regions have been produced. In one decade, daily wind vector coverage increases from 41 percent, to 77 percent, then to 93 percent, and spatial resolution improves from 50km, to 25 km, and to 12.5 km.

## GC32A-0216 1330h POSTER

### Simulation Studies for Active Microwave Profiling of Water Vapor in the Troposphere

Stephen S Leroy (+45 39157467; ssl@gps.caltech.edu)

Danish Meteorological Institute, Lyngbyvej 100, Copenhagen OE 2100, Denmark

WATS (WAter vapour and temperature in the Troposphere and Stratosphere) is an ESA proposal in progress whose objective is to profile water vapor throughout the Earth's troposphere with unprecedented vertical resolution, accuracy, coverage, and stability. It will do so by active limb sounding at three frequencies about the 22-GHz water vapor absorption feature. It is essentially an absorption measurement which takes advantage of the radio occultation technique.

A simulation-and-retrieval study will be presented to demonstrate how the major theoretical challenges and questions can be resolved. An atmospheric thin-screen geometry is assumed in order to reduce simulation complexity. In retrieval, a carefully tuned diffraction integral unwraps diffraction and atmospheric multipath effects induced by water vapor layering in the lower troposphere. Atmospheric parameters are then retrieved using a linearly constrained least squares algorithm. Results show that three frequencies should suffice for accurate retrieval of water vapor, and that total system drift of 0.1 dB/occ allows specific humidity retrievals accurate to 0.01 g/kg.

## GC32A-0217 1330h POSTER

### MODIS Data Products Management Tools and Services at the GES DAAC

Awdhesh K. Sharma[1] (301-614-5378; sharma@daac.gsfc.nasa.gov); S. Ahmad; P. Eaton ; J. Koziana; G. Leptoukh; D. Ouzounov; A. Savtchenko; G. Serafino; M. Sikder; B. Zhou

[1]NASA GSFC, GES DAAC Code 902 Building 32, Greenbelt, MD 20771, United States

Development and maintenance of climate records over decades is an essential function of a data system that provides robust and accessible archival system. The Goddard Space Flight Center (GSFC) Earth Sciences Distributed Active Archive Center (GES DAAC) manages and distributes data and information from NASA's Earth Observing System (EOS). The GES DAAC plays a significant role in enabling basic scientific research through developing and archiving global climate records and providing access to these scientific data to the general user community. The data are freely distributed to the global environmental community through various distribution methods, including the Internet World Wide Web, and direct connections.

The Moderate Resolution Imaging Spectroradiometer (MODIS) is the key instrument aboard the Terra satellite, launched on December 18. 1999, viewing the entire Earth's surface every 1 to 2 days, acquiring data in 36 channels in the visible and infrared spectral bands (0.4 to 14.4 microns), some channels are observed first time from space. Recently, the GES DAAC has met the new challenges of reprocessing (version 3) the large number of MODIS calibrated and uncalibrated radiances, geolocation, cloud mask, and an entire suite of atmosphere and ocean data products. This presentation will describe several features representing tools and services of the GES DAAC and the data products that are made available to the Earth science community, and the recent efforts and developments to provide interactive and user friendly services to the public.

MODIS Data Support Team (MDST) continues the tradition of quality support at the GES DAAC by providing expert assistance to users in accessing data products, information on visualization tools, documentation for data products and formats (HDF-EOS), information on the scientific content of products and metadata. Visit the MDST website at http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/MODIS/index.shtml

URL: http://daac.gsfc.nasa.gov

## GC32A-0218 1330h POSTER

### Calibration Monitoring and Intercomparison of Visible Satellite Observations Using Coldest-Brightest Cloud Pixels

Jennifer Colleen Mikovitz[1] (757-827-4623; j.c.mikovitz@larc.nasa.gov); Paul W. Stackhouse[2] (757-864-5368; p.w.stackhouse@larc.nasa.gov); Yongxiang Hu[2] (Y.HU@LaRC.NASA.GOV); Bruce A. Wielicki[2] (b.a.wielicki@larc.nasa.gov); Stephen J. Cox[1] (s.j.cox@larc.nasa.gov); Shashi K. Gupta[1] (s.k.gupta@larc.nasa.gov)

[1]Analytical Services and Materials, Suite 300 One Enterprise Parkway, Hampton, VA 23666

[2]NASA Langley Research Center, Atmospheric Sciences Competency, Hampton,, VA 23681

The monitoring of satellite visible calibration has become an important issue as the data collected from the satellites is used to study climate. Most of the work in this area focuses upon using earth targets in clear-skies. Spectral dependencies of various satellite instruments and surface properties along with atmospheric constituents like aerosols affect these calibrations.

Here, we present a methodology that uses the the coldest-brightest pixels from deep tropical convective cirrus anvil clouds. These clouds are ideally suited for this calibration check because they are relatively homogeneous and are dominated by multiple-scattering processes at the optically thick limit. The height of the clouds are such that spectrally dependent atmospheric scattering processing are minimized. The frequency of occurrence and microphysical properties of these clouds may change in time without affecting the cloud reflectivity characteristics. This technique was first developed to verify CERES broadband SW channel calibration.

Here, we adapt the method to evaluate its usefulness for AVHRR and geosynchronous observations from the International Satellite Cloud Climatology Project (ISCCP) inter-calibrated data set. The procedure uses a brightness temperature threshold to find the coldest pixels in tropical convective areas. The visible radiances are then binned in terms of solar zenith, satellite viewing and relative azimuth angles. Statistical analysis of the bins provides information regarding the reflectivity of these clouds which are compared to theoretical radiative transfer calculations. Anisotropic models are applied to the bin averaged reflectances to compute albedos. These statistical properties will be computed for multiple months within a time period, to check how the properties change over time. This will provide information regarding ISCCP calibration stability which can be compared to other instrument calibrations such as VIRS and eventually MODIS observations. After accounting for spectral responsivities, these targets may also be used to intercompare instruments and possibly to link new EOS era measurements with past satellite observations relevant to the construction of long-term climatologies.

Preliminary results from one month of data show that ratio of mean visible channel albedo to broadband CERES albedo gives 1.08 for combined ISCCP satellites and 1.16 for VIRS. The spread of albedo averages for the solar zenith angle bins between satellites are within the stated ISCCP relative uncertainty of 5%.

## GC32A-0219 1330h POSTER

### A Modified SVAT Model That Links the Geothermal Climate Signal to Land-Surface Processes

Xiaohua Lin[1] (734-763-4185; xiaohual@umich.edu)

Anthony W England[1] (734-763-5534; england@umich.edu)

Jason E Smerdon[2] (734-763-0084; jsmerdon@umich.edu)

Henry N Pollack[2] (734-763-0084; hpollack@umich.edu)

[1]University of Michigan, Department of Atmospheric, Oceanic and Space Sciences, 1301 Beal Ave, Rm 3240 EECS, Ann Arbor, MI 48109-2122, United States

[2]University of Michigan, Department of Geological Sciences and the Applied Physics Program, 4508 C C Little, Ann Arbor, MI 48109-1063, United States

The subsurface temperature signal to depths of several hundred meters has been utilized extensively by the geothermal community to reconstruct surface temperature history. In geothermal analyses, such reconstructions are based on the simple formulation of thermal conduction in a half-space with a time-dependent temperature boundary condition. However, the actual physical processes at the Earth's surface involve complex energy and moisture fluxes at the land-atmosphere interface and much remains to be learned about how those surface processes contribute to the geothermal climate signal. Soil-Vegetation-Atmosphere Transfer (SVAT) models have been developed in land surface hydrology to predict energy and moisture fluxes in the unsaturated zone given weather forcings. We approach the problem by modifying a high-fidelity SVAT model, extending it to up to a hundred meters in depth and exploring the impact of surface processes on the geothermal signal.

We will describe the model physics, compare model results with observed subsurface temperatures, and show the sensitivity of subsurface temperatures at various depths to the estimates of weather forcings at various temporal scales.

## GC32A-0220 1330h POSTER

### Global Observations of Forest Cover: Monitoring the World's Forests and other Land Cover Types

John R.G. Townshend[1,3] (301-405-4558; jotwnshe@geog.umd.edu)

Iwan Gunawan[2]

Christopher O. Justice[1] (justice@hermes.geog.umd.edu)

David L. Skole[4] (skole@msu.edu)

[1]Department of Geography, 2181 LeFrak Hall, University of Maryland, College Park, MD 20742, United States

[2]Natural Resources Inventory, BPPT New Building 19th floor, JI. M.H. Thamrin 8, Jakarta 10340, Indonesia

[3]Institute for Advanced Computer Studies, University of Maryland, College Park, MD 20742, United States

[4]Department of Geography, 218 Manly Miles, Michigan State University, East Lansing, MI 48824, United States

Global Observations of Forest Cover was originally set up as a pilot project of the Integrated Global Observation Strategy and has subsequently become a Panel of the Global Terrestrial Observation System. GOFC's overall objective is to improve the quality and availability of observations of forests at regional and global scales and to produce useful, timely and validated information products from these data for a wide variety of users. GOFC is a coordinated international effort working to provide ongoing space-based and in-situ observations of forests and other vegetation cover, for the sustainable management of terrestrial resources and to obtain an accurate, reliable, quantitative understanding of the terrestrial carbon budget. GOFC is working to accomplish its objectives by: providing a forum for users of satellite data to discuss their needs and for producers to respond through improvements to their programs; providing regional and global data sets containing information on: location of different forest types and major changes in forest cover; the distribution and dynamics of fires; biological functioning of forests. Its work includes promoting globally consistent data processing and interpretation methods; promoting international networks for data access, data sharing, and international collaboration and stimulating the production of improved products. Recently it has been decided to extend its scope to include all terrestrial land cover.

URL: http://www.gofc.org/gofc/

## GC32A-0221 1330h POSTER

### Laser Sounder Technique for Remotely Measuring Atmospheric CO2 Concentrations

James B Abshire[1] (301 614-6717; James.Abshire@gsfc.nasa.gov); G. James Collatz[1]; Xiaoli Sun[1]; Haris Riris[1]; Arlyn E. Andrews[1]; Michael Krainak[1]

[1]NASA Goddard Space Flight Center, Laser Remote Sensing Branch, Mail Code 924, Greenbelt, MD 20771, United States

We describe progress in developing a lidar technique for the remote measurement of the tropospheric CO2 concentrations. Our goal is to demonstrate a technique and technology that will permit measurements of the CO2 column abundance in the lower troposphere from aircraft at the few ppm level, with a capability of scaling to permit global CO2 measurements from orbit. Accurate remote sensing measurements of CO2 mixing ratio from aircraft and space appear difficult. Potential error sources include possible interferences from other trace gas species, the effects of clouds and aerosols in the path, and variability in dry air density caused by pressure or topographic changes. Some potential instrumental errors include frequency drifts in the transmitter and sensitivity drifts in the receiver. High signal-to-noise ratios are needed for estimates at the few ppm level.

We are developing a laser sounder approach as a candidate for these measurements. It uses 3 laser transmitters to permit simultaneous measurement of CO2 and O2 extinction, and aerosol backscatter at 1064 nm in the same atmospheric path. It directs the co-aligned laser beams from the lidar toward nadir, and measures the energy of the laser backscatter from land and water surfaces. During each measurement period, the two narrow linewidth lasers are rapidly tuned on and off the selected CO2 and O2 absorption lines. The receiver records and averages the energies of the laser echoes. The column extinction and column densities of both CO2 and O2 are estimated via the differential absorption lidar technique. For the on-line wavelength, the side of the gas absorption line is used, which weights its measurements to 0-4 km in the troposphere. Simultaneous measurements of O2 column abundance are made using an identical approach using an O2 line near 770 nm. Atmospheric baskscatter profiles are measured with the 1064 nm channel, which permits identifying and excluding measurements containing clouds or aerosols backscatter. Our active sounding technique has advantages over passive spectrometers in its high (MHz) spectral resolution and stability, the ability to measure at night and in dim-light, a narrow measurement swath, and the ability to simultaneously detect and exclude measurements with clouds or aerosols in the path.

For space, our concept is a lidar measuring at nadir in sun-synchronous orbit. Using dawn and dusk measurements make it possible to sample the diurnal variations in CO2 mixing ratios in the lower troposphere. A 1-m telescope is used as the receiver for all wavelengths. When averaging over 50 seconds, a SNR of 1500 is achievable for each gas at each on- and off-line measurement. Such a mission can furnish global maps of the lower tropospheric CO2 column abundance at dawn and dusk. Global coverage with an accuracy of a few ppm with a spatial resolution of 50,000 sq. km appears achievable each month.

We have demonstrated some key elements of the laser, PMT detector and receiver in the laboratory, including stable measurements of CO2 line shapes in an absorption cell using a fiber amplifier seeded by a tunable diode laser. Our plans for the next year are to complete our laboratory work and demonstrate the performance of the CO2 channel over a horizontal path. We have examined the feasibility of an airborne instrument operating at a 5 km altitude. Using commercially available fiber lasers and a 10 cm receiver lens appears sufficient for useful measurements with 5 second integration time.

## GC32A-0222 1330h POSTER

### Satellite Instrumentation and Orbits for High Accuracy Spectrally Resolved Radiometry for Climate Monitoring

John A Dykema[1] (6174955922; dykema@fas.harvard.edu)

Daniel B Kirk-Davidoff[2]

James G Anderson[1]

Richard M Goody[1]

[1]Division of Engineering and Applied Sciences, Harvard University, 12 Oxford St, Cambridge, MA 02138, United States

[2]Department of Earth and Planetary Sciences, Harvard University, 12 Oxford St, Cambridge, MA 02138, United States

The observation from space of spectrally resolved thermal radiance measurements calibrated to demonstrably high absolute accuracy from a Fourier transform spectrometer (FTS) provides a powerful means of long-term climate monitoring (Harries 2001). Achieving the radiometric accuracy goal of 0.1 K in equivalent temperature units places great demands on both the development of instrumentation and choice of satellite orbits. The instrument must meet the equally important goals of making radiometric measurements to the required level of accuracy and of convincing future experimenters that the stated level of accuracy was in fact achieved. Accomplishing these goals using available technology at a reasonable cost is possible by recognizing the trade-offs between accuracy and sensitivity inherent in the experimental physics, utilizing the advantages of spectral resolution for calibration, and employing a strategy of redundancy and overdetermination in the calibration system. The orbits should be chosen to maximize the temporal and spatial resolution at which mean radiances can be measured to an accuracy of 0.1 K or better. To determine which low earth orbits satisfy this objective, we model the sampling error of candidate orbits using the Salby Global Cloud Imagery (GCI) 11 micron brightness temperature dataset to simulate real variations in radiance. We compare averages over space and time of the GCI data, and of the same data sampled along the paths traversed by a downlooking satellite footprint for each potential orbit, including the role of anticipated instrument error properties. Laboratory experiments demonstrate that an FTS radiometer is capable of consistently achieving 0.1 K accuracy over a wide range of brightness temperatures in the mid-infrared. Flight data from INTESA (the INterferometer for Emission and Solar Absorption) indicate that an overdetermined calibration system provide critical diagnosis of radiometric accuracy during flight. The orbital simulation indicates that 0.1 K sampling accuracy may be obtained globally in the zonal mean with a constellation of 3 satellites. Taken together, these results show that a convincing accuracy of 0.1 K may be achieved for space-based radiance monitoring from a practically realizable program of linked laboratory, flight and satellite measurements.

## GC32A-0223 1330h POSTER

### High resolution oxygen A-band and water vapor band spectrometer

Qilong Min[1] ((518) 437-8742; min@asrc.cestm.albany.edu)

Lee Harrison[1] (lee@asrc.cestm.albany.edu)

Peter Kiedron[1] (kiedron@asrc.cestm.albany.edu)

Jerry berndt[1] (jerry@asrc.cestm.albany.edu)

Everette Joseph[2] (ejoseph@physics1.howard.edu)

[1]ASRC, State University of New York at Albany, 251 Fuller Road, Albany, NY 12203

[2]Dep. of Physics and Astronomy, Howard University, Howard University 2355 6TH Street, NW Washington, DC 20059

A high resolution oxygen A-band and water vapor band spectrometer has been developed and deployed for a field campaign at the ARM SGP site. The resolution of this instrument is 0.025 nm with out of band rejection better than $10^{-5}$. Given the performance of the instrument, we are able to retrieve both mean and variance of photon pathlength distributions. Studies are underway of the joint statistics of photon pathlength moments (mean and variance) and cloud optical properties that were observed during the deployment of the spectrometer at the ARM site. Preliminary results demonstrate that information derived from photon pathlength distributions is a powerful diagnostic tool for sky homogeneity and can provide constrains for radiative transfer calculation in cloudy atmospheres.

## GC32A-0224 1330h POSTER

### Pre-college Students Contributing to Long-Term Climate Studies

Elena B Sparrow (907-474-7699; ffebs@uaf.edu)

University of Alaska Fairbanks, School of Agriculture and Land Resources Management PO Box 757200, Fairbanks, AK 99775-7200, United States

Students in primary and secondary schools are engaged in long-term monitoring of the environment at or near their schools, in collaboration with scientists and educators, through the Global Learning and Observations to Benefit the Environment (GLOBE) Program. GLOBE students in more than 10,000 schools in 97 countries have reported data from almost 4 million science measurements in the areas of Atmosphere/Climate, Hydrology, Soils, Land Cover and Plant Phenology. These global data sets are available via the Internet to the world community for scientific research. After professional development workshops, GLOBE teachers guide their students in taking measurements according to scientific protocols and then in reporting their data through the Internet to the GLOBE Data Archive. Students are also guided in using these data for their own inquiry studies, analyzing scientific data, and in developing student-scientist and student-student partnerships at GLOBE schools around the world. Inclusion of GLOBE students in the research team would augment the problem of the huge expense and time involved for ground truthing remotely sensed data. NOAA's National Climate Data Center is using GLOBE student data to validate extreme events such as flash floods, hurricanes and tropical storms. The advantage of using GLOBE data is that much of the data arrives in real time compared to other volunteer data that comes by mail. The comprehensive suite of GLOBE measurements being collected by K-12 students is highly useful and complementary to long-term climate observations and Earth science research.

URL: http://www.globe.gov

## GC32A-0225 1330h POSTER

### Coincident Views of Earth - CERES and MISR Data Available from the Atmospheric Sciences Data Center

Robert K. Seals[1] (1-757-864-2466; r.k.seals@larc.nasa.gov)

Charlene H. Welch[1] (1-757-864-7431; charlene.welch@larc.nasa.gov)

[1]Science Applications International Corporation, One Enterprise Way, Suite 300, Hampton, VA 23666, United States

The experiments on NASA's Terra spacecraft are focused on collecting global data sets needed to study the inter-relationships inherent in the Earth's coupled atmosphere-land-ocean system. Issues such as the Earth's energy balance, global cloudiness, the effects of atmospheric aerosols, and land surface changes can be addressed by coincident data from experiments such as the Clouds and the Earth's Radiant Energy System (CERES) and the Multi-angle Imaging SpectroRadiometer (MISR).

An important feature of Terra is the ability to obtain data from multiple experiments looking at the same phenomena. CERES and MISR data available from the Atmospheric Sciences Data Center (ASDC) at NASA's Langley Research Center are used to demonstrate various complementary views of the Earth system. Examples are given of spatially and temporally coincident data covering phenomena such as large-scale weather systems, cloud patterns, aerosol concentrations from dust or fires, and seasonal variations in atmospheric and surface conditions over selected parts of the globe.

CERES uses broadband radiometric measurements in three channels to provide both solar-reflected and Earth-emitted radiation throughout the atmosphere and, in combination with simultaneous measurements from instruments such as the Moderate Resolution Imaging Spectrometer (MODIS), new information on cloud properties. MISR obtains precisely calibrated images taken simultaneously at nine different angles and four wavelengths (blue, green, red, and near-infrared) to provide data related to aerosols, clouds, and the land surface.

Information about all of the available CERES and MISR data products, as well as related products, and how to obtain them can be found at the ASDC web site, http://eosweb.larc.nasa.gov.

URL: http://eosweb.larc.nasa.gov

GC32A-0226 1330h POSTER

### Distribution of MODIS Data at the Goddard Earth Sciences DAAC

Krishna Tewari (301-614-5750; ktewari@gsfcsrvr4.gsfcmo.ecs.nasa.gov); A. K. Sharma[1] (301-614-5378; sharma@daac.gsfc.nasa.gov); S. Kreisler; M. Fuerst; J. Koziana; G. Leptoukh; G. Roth; R. Strub; B. Vollmer

[1]NASA GSFC, 8802 Ashcroft Dr, Laurel, MD 20708, United States

As a part of the NASA's Earth Observing System (EOS) mission, the Terra satellite was launched in December 1999 to investigate global climate changes. One of the five instruments on Terra is the Moderate Resolution Imaging Spectroradiometer (MODIS). The Goddard Earth Sciences Distributed Active Archive Center (GES DAAC) is responsible for ingesting, processing, archiving, and distribution of quality climate data derived from the MODIS. Currently the GES DAAC is distributing MODIS data at a rate of about 500 Gigabytes per day.

Access to MODIS products archived at GES DAAC is through the Web-based Hierarchical Ordering Mechanism (WHOM) and the EOS Data Gateway (EDG). These tools are simple to use and allow users to search, browse and order MODIS data products. In addition to these tools subscription services are currently used by the MODIS Science Team for calibration and validation purposes. This presentation will seek to answer various questions users might have regarding MODIS data and various capabilities available to users to search and order data products. Future plans of the GES DAAC for distributing data in a more efficient and timely manner will be presented. One of the plans allows users a quick way of accessing data through the Data Pool which is a large on-line cache. Data available on the Data Pool can be reviewed for fast delivery. The Data Services associated with the Data Pool such as search metadata, browse, and subset will be discussed.

URL: http://daac.gsfc.nasa.gov

GC32A-0227 1330h POSTER

### A Climatology Derived from GPS Radio-Occultations

Manuel de la Torre Juarez[1] (818-354-4548; mtj@jpl.nasa.gov)

George Hajj[1] (mtj@jpl.nasa.gov)

Byron Iilima[1] (mtj@jpl.nasa.gov)

Larry Romans[1] (mtj@jpl.nasa.gov)

Da Kuang[1] (mtj@jpl.nasa.gov)

[1]Jet Propulsion Laboratory/CalTech, M/S 238-600 4800 Oak Grove Drive, Pasadena, CA 91001-8099, United States

With the launch of two new radio occultation instruments, and the application of an improved processing of old data for periods where the Global Positioning System (GPS) signal was being distorted, a significant database of atmospheric occultation profiles has been created. The temporal coverage of the data record approaches three years. With this sort of data an occultation based climatology has been started. We discuss the features of radio occultation profiling for climate monitoring purposes, and present the first climatological results for temperature, and water vapor as obtained from the present database. In order to assess the capabilities of Radio occultations for climate monitoring, the occultation based climatology has been compared with climate records obtained from climate models like NCEP and ECMWF and from other remote sounding instruments when possible. The results of these comparisons will be presented.

G
C

## Reference Style for Abstracts

When referencing a meeting abstract, please use the following format, which indicates that this abstract volume is a supplement to the regular *Eos* issue. This format meets all AGU requirements for a complete reference.

Pan, C., The rotation of ron-rigid Earth., *Eos Trans. AGU, 82*(47), Fall Meet. Suppl., Abstract U41A-00005, 2001.